

November 30, 2011

Ray Pilapil, Manager  
Illinois Environmental Protection Agency  
Bureau of Air, Compliance Section #40  
1021 North Grand Avenue East  
Springfield, IL 62702

**Re: Annual Compliance Test Report  
Flare Performance Testing  
Cottonwood Hills Recycling and Disposal Facility**

Dear Mr. Pilapil:

Aquaterra Environmental Solutions, Inc. (Aquaterra) on behalf of our client, Waste Management of Illinois, Inc., is submitting the attached report of the *Open Flare Annual Test Report, Cottonwood Hills Recycling and Disposal Facility, Marissa, Illinois* dated November 2011. Please contact us at (618) 628-2001 with any questions or comments regarding this report.

Sincerely,  
**Aquaterra Environmental Solutions, Inc.**



Tia Jeter, P.E. *for*  
Project Manager



Andrew Limmer, P.G.  
Senior Project Manager

Enclosures

C: Ernest Dennison, P.E. - Waste Management of Illinois, Inc.  
Kevin Mattison – IEPA Bureau of Air – Des Plaines Office  
John Justice – IEPA Bureau of Air – Collinsville Office

**OPEN FLARE ANNUAL TEST REPORT  
COTTONWOOD HILLS RECYCLING AND DISPOSAL FACILITY  
MARISSA, ILLINOIS**

**Aquaterra Project Number 4733.10  
November 2011**

*Prepared For:*

**Waste Management of Illinois, Inc.  
601 Madison Avenue  
East St. Louis, Illinois 62201**

**AQUATERRA**

## TABLE OF CONTENTS

	<u>Page No.</u>
<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 FIELD ACTIVITIES .....</b>	<b>1</b>
<b>3.0 ANALYSIS AND RESULTS.....</b>	<b>2</b>
3.1 Visible Emissions.....	2
3.2 Fuel Heating Value .....	2
3.3 Fixed Gas Analysis .....	3
3.4 NMOC Analysis .....	4
3.5 Sulfur Compounds Analysis .....	4

### APPENDICES

Appendix A Field Logs

Appendix B Laboratory Analytical Results

Appendix C Calculations

**OPEN FLARE ANNUAL TEST REPORT  
COTTONWOOD HILLS RECYCLING AND DISPOSAL FACILITY  
MARISSA, ILLINOIS  
NOVEMBER 2011**

## **1.0 INTRODUCTION**

Aquaterra Environmental Solutions, Inc. (Aquaterra) was retained by Waste Management of Illinois, Inc., to perform the 2011 annual sampling of the open flare at the Cottonwood Hills Recycling and Disposal Facility (Cottonwood Hills RDF) located in Marissa, Illinois. The flare testing was performed in accordance with the requirements of the Illinois Environmental Protection Agency (IEPA), New Source Performance Standards (NSPS), and Construction Permit No. 06100058. Robert Hill, Jerry Jordan and Tim Pool of Aquaterra performed the Cottonwood Hills RDF flare testing on June 7, 2011, October 26, 2011, and November 8, 2011, respectively.

## **2.0 FIELD ACTIVITIES**

The Cottonwood Hills RDF landfill gas collection and control system is routed to a landfill gas open flare. The open flare is used for the destruction of landfill gas and the control of landfill gas emissions. The flare was installed per Construction Permit No. 06100058 and began operation on February 5, 2008. The flare was continually operated with a flame present at all times during the test period.

Three test events were conducted on the open flare. The test events were completed in June 2011, October 2011 and November 2011. The visual test of the open flare emissions was conducted during the October 2011 event. Landfill gas samples were collected for laboratory analyses during each test event. Copies of the Cottonwood Hills RDF flare testing field logs are presented in Appendix A. Field testing information including sampling times and flare system performance data are recorded on the field logs.

Samples CW-1, CW-2, and CW-3 were collected on June 7, 2011 and samples CW-4, CW-5 and CW-6 were collected on October 26, 2011. The landfill gas samples were collected under vacuum at the Cottonwood Hills RDF flare inlet using evacuated stainless steel tanks (Summa canisters). A calibrated flow control regulator was used to regulate the flow of landfill gas at the approximate flow rate of 100 milliliters per minute into each evacuated Summa canister. The landfill gas sample canisters were delivered to Columbia Analytical Services (CAS) in Simi Valley, California for laboratory analysis of net heating value, nonmethane organic compounds (NMOCs) and fixed gas analysis per ASTM D3588-98, and



EPA Method 25C and Method 3C. Copies of the laboratory reports are presented in Appendix B.

Additional landfill gas samples CW 1, CW 2, CW 3, CW 4, CW 5 and CW 6 were collected on June 7, 2011 and November 8, 2011. These landfill gas samples were collected using 1.0 Liter Tedlar bags at the sample port located on the Cottonwood Hills RDF flare inlet. The landfill gas samples were delivered to CAS for analysis of sulfur compounds per ASTM D5504-08. Copies of the laboratory reports are presented in Appendix B.

### 3.0 ANALYSIS AND RESULTS

The Cottonwood Hills RDF flare testing was performed in accordance with Construction Permit No. 06100058, NSPS, and the relevant guidelines for test methods provided at 40 CFR Part 60, Appendix A. A discussion of the results is provided in the following sections.

#### 3.1 Visible Emissions

Visible emissions (opacity) testing of the Cottonwood Hills RDF flare was performed on October 26, 2011, in accordance with USEPA Method 22, *Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares*. The visual emissions from the open flare were continuously monitored for a 2-hour timeframe and documented at 5-minute intervals. A 5-minute rest period occurred after each 20-minute observation period. The Method 22 test result for the Cottonwood Hills RDF flare are summarized on the Method 22 Testing Field Logs presented in Appendix A. The results of the visible emissions test indicated no detectable visible emissions from the Cottonwood Hills RDF flare, therefore, the flare was operated within the maximum permitted emission limit. A summary of the acceptable Cottonwood Hills RDF flare visible emissions testing results is presented as follows.

Actual Visible Emission Event per 2 hours	Allowable Visible Emission Event per 2 hours
0 seconds	5 minutes

#### 3.2 Fuel Heating Value

Six of the landfill gas samples collected during the June 2011 and October 2011 events were analyzed for net heating value by ASTM Method D3588 and fixed gases per EPA Method 3C. The results of the laboratory analyses are provided in Appendix B. The results of the Method 3C analysis for sample CW-3 collected on June 7, 2011 indicate air intrusion

possibly occurred in the Summa canister as the nitrogen and oxygen concentrations in the canister are 76% and 22% respectively. This air intrusion more than likely occurred prior to the sample collection, possibly during canister shipment, as there was minimal vacuum in the canister prior to sample collection. As such, the sample analyzed is not indicative of the true quality of gas being combusted in the landfill flare. Therefore, the results of the analysis of sample CW-3 collected on June 7, 2011 are not considered valid and will not be discussed further in this report.

The laboratory heating value analysis indicated the net heating value of the landfill gas at the time of sample collection was in compliance with the minimum requirements as described in 40 CFR 60.18(c)(3)(ii). The net heating value of the landfill gas during the test events was also calculated based on the concentration of methane in the landfill gas, in accordance with 40 CFR 60.18(f)(3) and 40 CFR 60.754(e). Per 40 CFR 60.754(e), the net heating value of combusted landfill gas is calculated from the concentration of methane in the landfill gas as measured by EPA Method 3C. The measurement of other organic components, hydrogen, and carbon monoxide is not applicable. The results of the net heating value calculation comply with the requirements of 40 CFR 60.18(c)(3)(ii) and not surprisingly are slightly less than the laboratory measured values. This is due to the fact that the calculation considers the heating value of only the methane portion of the landfill gas, while the laboratory analysis considers the heating value of all components of landfill gas contributing to the net heating value, including methane and other organic compounds. Detailed calculations are provided in Appendix C. A summary of the laboratory results, calculated heating values and allowable heating value for the Cottonwood Hills RDF flare is presented in the following table.

<b>Date</b>	<b>Run No.</b>	<b>Laboratory Analytical Heating Value (MJ/scm)</b>	<b>Calculated Heating Value (MJ/scm)</b>	<b>Minimum Allowable Heating Value (MJ/scm)</b>
6/7/11	CW-1	17.7	17.1	7.45
6/7/11	CW-2	19.4	19.1	7.45
10/26/11	CW-4	16.7	16.5	7.45
10/26/11	CW-5	16.8	16.4	7.45
10/26/11	CW-6	16.6	16.3	7.45

*MJ/scm: Mega joule per standard cubic meter*

### **3.3 Fixed Gas Analysis**

Per the requirements of Construction Permit No. 06100058, landfill gas samples collected during the June 2011 and October 2011 events were analyzed for fixed gases, including

methane and carbon monoxide, by EPA Method 3C. The results of the analysis, reported as percent by volume (%), are provided in the following table.

Date Collected	6/7/2011		10/26/2011			Average
Parameter	CW-1	CW-2	CW-4	CW-5	CW-6	
Hydrogen	0.8%	0.8%	0.7%	0.7%	0.7%	0.8%
Oxygen	2.8%	0.6%	1.7%	1.8%	2.0%	1.8%
Nitrogen	8.5%	0.7%	12.1%	12.3%	12.9%	9.3%
Carbon Monoxide	ND	ND	ND	ND	ND	ND
Methane	51.4%	57.1%	49.4%	49.3%	48.7%	51.2%
Carbon Dioxide	36.5%	40.6%	35.9%	35.8%	35.5%	36.9%

ND: Not detected at or above the reporting limit

### 3.4 NMOC Analysis

Per the requirements of Construction Permit No. 06100058, landfill gas samples collected during the June 2011 and October 2011 events were analyzed for NMOCs by EPA Method 25C. The results of the analysis are provided in the table below and indicate an average NMOC content of 6,380 parts per million by volume.

Date	Run No.	NMOC Content (ppmv)
6/7/11	CW-1	6,700
6/7/11	CW-2	7,800
10/26/11	CW-4	5,500
10/26/11	CW-5	5,800
10/26/11	CW-6	6,100
Average		6,380

ppmv: parts per million by volume

### 3.5 Sulfur Compounds Analysis

A total of six landfill gas samples collected during the June 2011 and November 2011 events were analyzed for twenty Sulfur compounds, including hydrogen sulfide, by ASTM Method D 5504-08. The results of the laboratory analyses are provided in Appendix B. The average sulfur content for the samples analyzed was 47.6 ppmv. A summary of the sulfur compounds tested for and their concentrations is provided on the following table.

**Open Flare Annual Test Report  
Cottonwood Hills Recycling and Disposal Facility  
November 2011**

Date collected	Units	6/7/2011			11/8/2011		
Parameter		CW 1	CW 2	CW 3	CW 4	CW 5	CW 6
Hydrogen Sulfide	ppbv	28,000	30,000	26,000	20,000	24,000	23,000
Carbonyl Sulfide	ppbv	97	100	85	120	120	110
Methyl Mercaptan	ppbv	5,700	5,900	5,100	5,500	6,200	6,000
Ethyl Mercaptan	ppbv	140	150	120	150	170	170
Dimethyl Sulfide	ppbv	13,000	13,000	11,000	16,000	16,000	16,000
Carbon Disulfide	ppbv	53	58	46	90	92	88
Isopropyl Mercaptan	ppbv	380	400	340	470	520	500
tert-Butyl Mercaptan	ppbv	650	660	550	730	760	720
n-Propyl Mercaptan	ppbv	54	57	43	55	63	60
Ethyl Methyl Sulfide	ppbv	110	120	96	150	150	140
Thiophene	ppbv	430	450	380	530	580	560
Isobutyl Mercaptan	ppbv	120	120	100	150	160	150
Diethyl Sulfide	ppbv	18	20	14	20	19	17
n-Butyl Mercaptan	ppbv	63	64	48	72	79	78
Dimethyl Disulfide	ppbv	13	12	10	82	54	49
3-Methylthiophene	ppbv	98	100	87	130	130	130
Tetrahydrothiophene	ppbv	19	19	16	26	25	24
2,5-Dimethylthiophene	ppbv	ND	ND	ND	9	11	10
2-Ethylthiophene	ppbv	10	11	ND	10	13	12
Diethyl Disulfide	ppbv	ND	ND	ND	ND	ND	ND
<b>Total Per Sample</b>	ppbv	48,955	51,241	44,035	44,293.9	49,146	47,818
<b>Average</b>	ppmv	47.6					

*ppbv: parts per billion by volume*

*ppmv: parts per million by volume*

*ND: Not detected at or above reporting limit*

**APPENDIX A**

**FIELD LOGS**

# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## LANDFILL GAS FLARE TESTING LOG

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

Sampler Robert Hill

Date 6/7/2011  
Sample I.D. CW-1  
Canister I.D. ISC00246  
Canister Vol. 1.0 liter  
Tedlar Bag I.D. 90675-41296  
Sample Vol. 0.5 liter

### Temperature Measurements

Flare Temp.\* 1314 Deg. F  
Gas Temp.\*\* 145.2 Deg. F

\* Measured with CAT 123-6700 Infrared Thermometer II with Laser Sighting

\*\* Measured with in-line thermometer

### Pressure Measurement

Static Pressure\* 0.00 Inches H<sub>2</sub>O

\* Measured with Shortridge Instruments, Inc. Airdata Multimeter ADM 860 #M00577

### Summa Canister Vacuum Readings

Initial Vacuum -94 Inches Hg  
Final Vacuum -8 Inches Hg

Start Time 13:30  
End Time 13:45



# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## LANDFILL GAS FLARE TESTING LOG

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

Sampler Robert Hill

Date 6/7/2011  
Sample I.D. CW-2  
Canister I.D. ISC00063  
Canister Vol. 1.0 liter  
Tedlar Bag I.D. 90675-41301  
Sample Vol. 0.5 liter

### Temperature Measurements

Flare Temp.\* 1434 Deg. F  
Gas Temp.\*\* 145.2 Deg. F

\* Measured with CAT 123-6700 Infrared Thermometer II with Laser Sighting

\*\* Measured with in-line thermometer

### Pressure Measurement

Static Pressure\* 0 Inches H<sub>2</sub>O

\* Measured with Shortridge Instruments, Inc. Airdata Multimeter ADM 860 #M00577

### Summa Canister Vacuum Readings

Initial Vacuum -100 Inches Hg  
Final Vacuum -9 Inches Hg

Start Time 13:49  
End Time 14:06

# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## LANDFILL GAS FLARE TESTING LOG

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

Sampler Robert Hill

Date 6/7/2011  
Sample I.D. CW-3  
Canister I.D. ISC00774  
Canister Vol. 1.0 liter  
Tedlar Bag I.D. 90675-41299  
Sample Vol. 0.5 liter

### Temperature Measurements

Flare Temp.\*                      Deg. F

Gas Temp.\*\*                      Deg. F

\* Measured with CAT 123-6700 Infrared Thermometer II with Laser Sighting

\*\* Measured with in-line thermometer

### Pressure Measurement

Static Pressure\*                      Inches H<sub>2</sub>O

\* Measured with Shortridge Instruments, Inc. Airdata Multimeter ADM 860 #M00577

### Summa Canister Vacuum Readings

Initial Vacuum                      Inches Hg

Final Vacuum                      Inches Hg

Start Time                     

End Time

# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## LANDFILL GAS FLARE TESTING LOG

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

Sampler Jerry Jordan

Date 10/26/2011  
Sample I.D. CW-4  
Canister I.D. ISC00198  
Canister Vol. 1.0 liter  
Tedlar Bag I.D. NA  
Sample Vol. NA liter

### Temperature Measurements

Flare Temp.\* 1393 Deg. F  
Gas Temp.\*\* 120 Deg. F

\* Measured with CAT 123-6700 Infrared Thermometer II with Laser Sighting

\*\* Measured with in-line thermometer

### Pressure Measurement

Static Pressure\* 1.6 Inches H<sub>2</sub>O

\* Measured with Shortridge Instruments, Inc. Airdata Multimeter ADM 860 #M00577

### Summa Canister Vacuum Readings

Initial Vacuum -22 Inches Hg  
Final Vacuum -3.5 Inches Hg

Start Time 11:45  
End Time 11:58

# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## LANDFILL GAS FLARE TESTING LOG

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

Sampler Jerry Jordan

Date 10/26/2011  
Sample I.D. CW-5  
Canister I.D. ISC00067  
Canister Vol. 1.0 liter  
Tedlar Bag I.D. NA  
Sample Vol. NA liter

### Temperature Measurements

Flare Temp.\* 1390 Deg. F  
Gas Temp.\*\* 120 Deg. F

\* Measured with CAT 123-6700 Infrared Thermometer II with Laser Sighting

\*\* Measured with in-line thermometer

### Pressure Measurement

Static Pressure\* 1.5 Inches H<sub>2</sub>O

\* Measured with Shortridge Instruments, Inc. Airdata Multimeter ADM 860 #M00577

### Summa Canister Vacuum Readings

Initial Vacuum -28 Inches Hg  
Final Vacuum -5 Inches Hg

Start Time 12:25  
End Time 12:39

# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## LANDFILL GAS FLARE TESTING LOG

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

Sampler Jerry Jordan

Date 10/26/2011  
Sample I.D. CW-6  
Canister I.D. ISC00803  
Canister Vol. 1.0 liter  
Tedlar Bag I.D. NA  
Sample Vol. NA liter

### Temperature Measurements

Flare Temp.\* 1392 Deg. F

Gas Temp.\*\* 119 Deg. F

\* Measured with CAT 123-6700 Infrared Thermometer II with Laser Sighting

\*\* Measured with in-line thermometer

### Pressure Measurement

Static Pressure\* 1.6 Inches H<sub>2</sub>O

\* Measured with Shortridge Instruments, Inc. Airdata Multimeter ADM 860 #M00577

### Summa Canister Vacuum Readings

Initial Vacuum -29.5 Inches Hg

Final Vacuum -5 Inches Hg

Start Time 12:50

End Time 13:02

# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## LANDFILL GAS FLARE TESTING LOG

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

Sampler Tim Pool

Date 11/8/2011  
Sample I.D. CW-4  
Canister I.D. NA  
Canister Vol. NA liter  
Tedlar Bag I.D. 90675-46114  
Sample Vol. 0.5 liter

### Temperature Measurements

Flare Temp.\* 898 Deg. F  
Gas Temp.\*\* 112 Deg. F

\* Measured with CAT 123-6700 Infrared Thermometer II with Laser Sighting

\*\* Measured with in-line thermometer

### Pressure Measurement

Static Pressure\* - Inches H<sub>2</sub>O

\* Gauge was down

### Summa Canister Vacuum Readings

Initial Vacuum \_\_\_\_\_ Inches Hg  
Final Vacuum \_\_\_\_\_ Inches Hg

Start Time \_\_\_\_\_  
End Time \_\_\_\_\_



# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## LANDFILL GAS FLARE TESTING LOG

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

Sampler Tim Pool

Date 11/8/2011  
Sample I.D. CW-5  
Canister I.D. NA  
Canister Vol. NA liter  
Tedlar Bag I.D. 90675-46309  
Sample Vol. 0.5 liter

### Temperature Measurements

Flare Temp.\* 834 Deg. F  
Gas Temp.\*\* 112 Deg. F

\* Measured with CAT 123-6700 Infrared Thermometer II with Laser Sighting

\*\* Measured with in-line thermometer

### Pressure Measurement

Static Pressure\* - Inches H<sub>2</sub>O

\* Gauge was down

### Summa Canister Vacuum Readings

Initial Vacuum \_\_\_\_\_ Inches Hg  
Final Vacuum \_\_\_\_\_ Inches Hg

Start Time \_\_\_\_\_  
End Time \_\_\_\_\_

# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## LANDFILL GAS FLARE TESTING LOG

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

Sampler Tim Pool

Date 11/8/2011  
Sample I.D. CW-6  
Canister I.D. NA  
Canister Vol. NA liter  
Tedlar Bag I.D. 90675-46123  
Sample Vol. 0.5 liter

### Temperature Measurements

Flare Temp.\* 861 Deg. F

Gas Temp.\*\* 112 Deg. F

\* Measured with CAT 123-6700 Infrared Thermometer II with Laser Sighting

\*\* Measured with in-line thermometer

### Pressure Measurement

Static Pressure\* - Inches H<sub>2</sub>O

\* Gauge was down

### Summa Canister Vacuum Readings

Initial Vacuum \_\_\_\_\_ Inches Hg

Final Vacuum \_\_\_\_\_ Inches Hg

Start Time \_\_\_\_\_

End Time \_\_\_\_\_

**APPENDIX B**  
**LABORATORY REPORTS**

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## LABORATORY REPORT

July 1, 2011

Tom Jacobsmeyer  
Aquaterra Environmental Solutions, Inc.  
13 Executive Dr., Suite 1  
Fairview Heights, IL 62208

### RE: 2011 Cottonwood RDF Flare

Dear Tom:

Enclosed are the results of the samples submitted to our laboratory on June 20, 2011. For your reference, these analyses have been assigned our service request number P1102313.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at [www.caslab.com](http://www.caslab.com). Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

Columbia Analytical Services, Inc. is certified by the California Department of Health Services, NELAP Laboratory Certificate No. 02115CA; Arizona Department of Health Services, Certificate No. AZ0694; Florida Department of Health, NELAP Certification E871020; New Jersey Department of Environmental Protection, NELAP Laboratory Certification ID #CA009; New York State Department of Health, NELAP NY Lab ID No: 11221; Oregon Environmental Laboratory Accreditation Program, NELAP ID: CA20007; The American Industrial Hygiene Association, Laboratory #101661; United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), Certificate No. L10-3-R1; Pennsylvania Registration No. 68-03307; TX Commission of Environmental Quality, NELAP ID T104704413-11-2; Minnesota Department of Health, NELAP Certificate No. 219474; Washington State Department of Ecology, ELAP Lab ID: C946. Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact me for information corresponding to a particular certification.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

**Columbia Analytical Services, Inc.**

Sue Anderson  
Project Manager

Client: Aquaterra Environmental Solutions, Inc.  
Project: 2011 Cottonwood RDF Flare

CAS Project No: P1102313

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## CASE NARRATIVE

The samples were received intact under chain of custody on June 20, 2011 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

### BTU and CHONS Analysis

The results for BTU and CHONS were generated according to ASTM D 3588-98. The following analyses were performed and used to calculate the BTU and CHONS results.

#### C2 through C6 Hydrocarbon Analysis

The samples were analyzed according to modified EPA Method TO-3 for C<sub>2</sub> through >C<sub>6</sub> hydrocarbons using a gas chromatograph equipped with a flame ionization detector (FID).

#### Fixed Gases Analysis

The samples were also analyzed for fixed gases (hydrogen, oxygen/argon, nitrogen, carbon monoxide, methane and carbon dioxide) according to ASTM D 1946 using a gas chromatograph equipped with a thermal conductivity detector (TCD).

#### Hydrogen Sulfide Analysis

The were also analyzed for hydrogen sulfide per ASTM D 5504-08 using a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD).

### Total Gaseous Non-Methane Organics as Methane Analysis

The samples were also analyzed for total gaseous non-methane organics as methane according to modified EPA Method 25C. The analyses included a single sample injection (method modification) analyzed by gas chromatography using flame ionization detection/total combustion analysis.

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*The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. (CAS) is not responsible for utilization of less than the complete report.*

*Use of Columbia Analytical Services, Inc. (CAS) Name. Client shall not use CAS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to CAS any test result, tolerance or specification derived from CAS's data ("Attribution") without CAS's prior written consent, which may be withheld by CAS for any reason in its sole discretion. To request CAS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If CAS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use CAS's name or trademark in any Materials or Attribution shall be deemed denied. CAS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of CAS's name or trademark may cause CAS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.*



## DETAIL SUMMARY REPORT

Client: Aquaterra Environmental Solutions, Inc.  
Project ID: 2011 Cottonwood RDF Flare

Service Request: P1102313

Date Received: 6/20/2011  
Time Received: 09:30

Client Sample ID	Lab Code	Matrix	Date Collected	Time Collected	Container ID	Pi1 (psig)	Pf1 (psig)	TO-3 Modified - C1C6+ Can	3C Modified - Fxd Gases Can	ASTM D5504-01 - H2S Can	25C Modified - TGNMO+ 1X Can
CW-1	P1102313-001	Air	6/7/2011	13:45	1SC00246	12.11	12.11	X	X	X	X
CW-2	P1102313-002	Air	6/7/2011	14:06	1SC00063	12.01	12.01	X	X	X	X
CW-3	P1102313-003	Air	6/7/2011	14:10	1SC00774	11.58	11.58	X	X	X	X



WM00559

### Sample Acceptance Check Form

Client: Aquaterra Environmental Solutions, Inc. Work order: P1102313  
 Project: 2011 Cottonwood RDF Flare  
 Sample(s) received on: 6/20/11 Date opened: 6/20/11 by: MZAMORA

**Note:** This form is used for all samples received by CAS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

	Yes	No	N/A
1 Were <b>sample containers</b> properly marked with client sample ID?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 Container(s) <b>supplied by CAS</b> ?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3 Did <b>sample containers</b> arrive in good condition?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4 Were <b>chain-of-custody</b> papers used and filled out?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5 Did <b>sample container labels</b> and/or tags agree with custody papers?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
6 Was <b>sample volume</b> received adequate for analysis?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7 Are samples within specified holding times?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8 Was proper <b>temperature</b> (thermal preservation) of cooler at receipt adhered to?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Cooler Temperature _____ °C Blank Temperature _____ °C			
9 Was a <b>trip blank</b> received?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
10 Were <b>custody seals</b> on outside of cooler/Box?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Location of seal(s)? _____ Sealing Lid?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were signature and date included?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were seals intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were custody seals on outside of sample container?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Location of seal(s)? _____ Sealing Lid?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were signature and date included?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were seals intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
11 Do containers have appropriate <b>preservation</b> , according to method/SOP or Client specified information?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Is there a client indication that the submitted samples are <b>pH</b> preserved?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were <b>VOA vials</b> checked for presence/absence of air bubbles?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Does the client/method/SOP require that the analyst check the sample pH and <u>if necessary</u> alter it?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
12 <b>Tubes:</b> Are the tubes capped and intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Do they contain moisture?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
13 <b>Badges:</b> Are the badges properly capped and intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Are dual bed badges separated and individually capped and intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P1102313-001.01	1.0 L Source Can					
P1102313-002.01	1.0 L Source Can					
P1102313-003.01	1.0 L Source Can					

Explain any discrepancies: (include lab sample ID numbers): \_\_\_\_\_

The canisters were not tagged; they were assigned by the asset tag number indicated on the COC.

Canisters were inadvertently shipped to another lab before being sent back to CAS so they were received pressurized.

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.  
**Client Sample ID:** CW-1  
**Client Project ID:** 2011 Cottonwood RDF Flare

CAS Project ID: P1102313  
CAS Sample ID: P1102313-001

**Test Code:** ASTM D3588-98  
**Analyst:** Wade Henton/Dante Munoz-Castaneda  
**Sampling Media:** 1.0 L Summa Canister  
**Test Notes:**  
**Container ID:** 1SC00246

**Date Collected:** 6/7/11  
**Date Received:** 6/20/11

**Initial Pressure (psig):** 12.11      **Final Pressure (psig):** 12.11

Canister Dilution Factor: 1.00

Components	Result	Result	Data Qualifier
	Volume %	Weight %	
Hydrogen	0.36	0.03	
Oxygen + Argon	1.32	1.52	
Nitrogen	56.77	57.09	
Carbon Monoxide	< 0.01	< 0.01	
Methane	24.27	13.97	
Carbon Dioxide	17.21	27.19	
Hydrogen Sulfide	< 0.01	< 0.01	
Ethane	< 0.01	< 0.01	
Propane	< 0.01	< 0.01	
Butanes	< 0.01	< 0.01	
Pentanes	0.01	0.04	
Hexanes	0.01	0.03	
> Hexanes	0.03	0.12	
<b>TOTALS</b>	<b>99.99</b>	<b>99.99</b>	

Components	Mole %	Weight %
Carbon	14.34	18.00
Hydrogen	33.91	3.57
Oxygen + Argon	12.73	21.30
Nitrogen	39.02	57.13
Sulfur	< 0.10	< 0.10

Specific Gravity (Air = 1)		0.9618
Specific Volume	ft <sup>3</sup> /lb	13.62
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft <sup>3</sup>	249.6
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft <sup>3</sup>	224.8
Gross Heating Value (Water Saturated at 0.25636 psia)	BTU/ft <sup>3</sup>	245.0
Net Heating Value (Water Saturated at 0.25636 psia)	BTU/ft <sup>3</sup>	220.6
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	3,400.7
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	3,062.2
Compressibility Factor "Z" (60 F, 14.696 psia)		0.9988

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.  
**Client Sample ID:** CW-2  
**Client Project ID:** 2011 Cottonwood RDF Flare

CAS Project ID: P1102313  
CAS Sample ID: P1102313-002

**Test Code:** ASTM D3588-98  
**Analyst:** Wade Henton/Dante Munoz-Castaneda  
**Sampling Media:** 1.0 L Summa Canister  
**Test Notes:**  
**Container ID:** 1SC00063

**Date Collected:** 6/7/11  
**Date Received:** 6/20/11

**Initial Pressure (psig):** 12.01      **Final Pressure (psig):** 12.01

Canister Dilution Factor: 1.00

Components	Result	Result	Data Qualifier
	Volume %	Weight %	
Hydrogen	0.40	0.03	
Oxygen + Argon	0.27	0.31	
Nitrogen	52.43	52.82	
Carbon Monoxide	< 0.01	< 0.01	
Methane	27.37	15.79	
Carbon Dioxide	19.44	30.78	
Hydrogen Sulfide	< 0.01	< 0.01	
Ethane	< 0.01	< 0.01	
Propane	< 0.01	< 0.01	
Butanes	< 0.01	< 0.01	
Pentanes	0.01	0.04	
Hexanes	0.01	0.04	
> Hexanes	0.05	0.19	
<b>TOTALS</b>	<b>99.99</b>	<b>99.99</b>	

Components	Mole %	Weight %
Carbon	15.58	20.40
Hydrogen	36.80	4.04
Oxygen + Argon	13.01	22.70
Nitrogen	34.61	52.86
Sulfur	< 0.10	< 0.10

Specific Gravity (Air = 1)		0.9600
Specific Volume	ft <sup>3</sup> /lb	13.65
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft <sup>3</sup>	282.2
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft <sup>3</sup>	254.1
Gross Heating Value (Water Saturated at 0.25636 psia)	BTU/ft <sup>3</sup>	276.9
Net Heating Value (Water Saturated at 0.25636 psia)	BTU/ft <sup>3</sup>	249.4
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	3,851.6
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	3,468.5
Compressibility Factor "Z" (60 F, 14.696 psia)		0.9987



## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.  
**Client Sample ID:** CW-3  
**Client Project ID:** 2011 Cottonwood RDF Flare

CAS Project ID: P1102313  
CAS Sample ID: P1102313-003

**Test Code:** ASTM D3588-98  
**Analyst:** Wade Henton/Dante Munoz-Castaneda  
**Sampling Media:** 1.0 L Summa Canister  
**Test Notes:**  
**Container ID:** 1SC00774

**Date Collected:** 6/7/11  
**Date Received:** 6/20/11

**Initial Pressure (psig):** 11.58      **Final Pressure (psig):** 11.58

Canister Dilution Factor: 1.00

Components	Result Volume %	Result Weight %	Data Qualifier
Hydrogen	< 0.01	< 0.01	
Oxygen + Argon	11.48	12.91	
Nitrogen	88.00	86.58	
Carbon Monoxide	< 0.01	< 0.01	
Methane	0.28	0.16	
Carbon Dioxide	0.22	0.34	
Hydrogen Sulfide	< 0.01	< 0.01	
Ethane	< 0.01	< 0.01	
Propane	< 0.01	< 0.01	
Butanes	< 0.01	< 0.01	
Pentanes	< 0.01	< 0.01	
Hexanes	< 0.01	< 0.01	
> Hexanes	< 0.01	< 0.01	
<b>TOTALS</b>	<b>99.99</b>	<b>99.99</b>	

Components	Mole %	Weight %
Carbon	0.25	0.21
Hydrogen	0.56	< 0.10
Oxygen + Argon	11.64	13.16
Nitrogen	87.54	86.59
Sulfur	< 0.10	< 0.10

Specific Gravity (Air = 1)		0.9830
Specific Volume	ft <sup>3</sup> /lb	13.33
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft <sup>3</sup>	2.9
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft <sup>3</sup>	2.6
Gross Heating Value (Water Saturated at 0.25636 psia)	BTU/ft <sup>3</sup>	2.8
Net Heating Value (Water Saturated at 0.25636 psia)	BTU/ft <sup>3</sup>	2.5
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	38.2
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	34.4
Compressibility Factor "Z" (60 F, 14.696 psia)		0.9997

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** CW-1

**Client Project ID:** 2011 Cottonwood RDF Flare

CAS Project ID: P1102313

CAS Sample ID: P1102313-001

Test Code: EPA Method 3C Modified

Instrument ID: HP5890 II/GC1/TCD

Analyst: Dante Munoz-Castaneda

Sampling Media: 1.0 L Summa Canister

Test Notes:

Container ID: 1SC00246

Date Collected: 6/7/11

Date Received: 6/20/11

Date Analyzed: 6/29/11

Volume(s) Analyzed: 0.10 ml(s)

Initial Pressure (psig): 12.11

Final Pressure (psig): 12.11

Canister Dilution Factor: 1.00

CAS #	Compound	Result %, v/v	MRL %, v/v	Data Qualifier
1333-74-0	<b>Hydrogen</b>	<b>0.385</b>	0.10	
7782-44-7	<b>Oxygen +</b>			
7440-37-1	<b>Argon</b>	<b>1.32</b>	0.10	
7727-37-9	<b>Nitrogen</b>	<b>56.8</b>	0.10	
630-08-0	Carbon Monoxide	ND	0.10	
74-82-8	<b>Methane</b>	<b>24.3</b>	0.10	
124-38-9	<b>Carbon Dioxide</b>	<b>17.2</b>	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.



## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** CW-2

**Client Project ID:** 2011 Cottonwood RDF Flare

CAS Project ID: P1102313

CAS Sample ID: P1102313-002

Test Code: EPA Method 3C Modified

Instrument ID: HP5890 II/GC1/TCD

Analyst: Dante Munoz-Castaneda

Sampling Media: 1.0 L Summa Canister

Test Notes:

Container ID: 1SC00063

Date Collected: 6/7/11

Date Received: 6/20/11

Date Analyzed: 6/29/11

Volume(s) Analyzed: 0.10 ml(s)

Initial Pressure (psig): 12.01 Final Pressure (psig): 12.01

Canister Dilution Factor: 1.00

CAS #	Compound	Result %, v/v	MRL %, v/v	Data Qualifier
1333-74-0	<b>Hydrogen</b>	<b>0.404</b>	0.10	
7782-44-7	<b>Oxygen +</b>			
7440-37-1	<b>Argon</b>	<b>0.269</b>	0.10	
7727-37-9	<b>Nitrogen</b>	<b>52.4</b>	0.10	
630-08-0	Carbon Monoxide	ND	0.10	
74-82-8	<b>Methane</b>	<b>27.4</b>	0.10	
124-38-9	<b>Carbon Dioxide</b>	<b>19.4</b>	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** CW-3

**Client Project ID:** 2011 Cottonwood RDF Flare

CAS Project ID: P1102313

CAS Sample ID: P1102313-003

Test Code: EPA Method 3C Modified

Instrument ID: HP5890 II/GC1/TCD

Analyst: Dante Munoz-Castaneda

Sampling Media: 1.0 L Summa Canister

Test Notes:

Container ID: 1SC00774

Date Collected: 6/7/11

Date Received: 6/20/11

Date Analyzed: 6/29/11

Volume(s) Analyzed: 0.10 ml(s)

Initial Pressure (psig): 11.58

Final Pressure (psig): 11.58

Canister Dilution Factor: 1.00

CAS #	Compound	Result %, v/v	MRL %, v/v	Data Qualifier
1333-74-0	Hydrogen	ND	0.10	
7782-44-7	<b>Oxygen +</b>			
7440-37-1	<b>Argon</b>	<b>11.5</b>	0.10	
7727-37-9	<b>Nitrogen</b>	<b>88.0</b>	0.10	
630-08-0	Carbon Monoxide	ND	0.10	
74-82-8	<b>Methane</b>	<b>0.280</b>	0.10	
124-38-9	<b>Carbon Dioxide</b>	<b>0.222</b>	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** Method Blank

**Client Project ID:** 2011 Cottonwood RDF Flare

CAS Project ID: P1102313

CAS Sample ID: P110629-MB

Test Code: EPA Method 3C Modified

Instrument ID: HP5890 II/GC1/TCD

Analyst: Dante Munoz-Castaneda

Sampling Media: 1.0 L Summa Canister

Test Notes:

Date Collected: NA

Date Received: NA

Date Analyzed: 6/29/11

Volume(s) Analyzed: 0.10 ml(s)

CAS #	Compound	Result %, v/v	MRL %, v/v	Data Qualifier
1333-74-0	Hydrogen	ND	0.10	
7782-44-7	Oxygen +			
7440-37-1	Argon	ND	0.10	
7727-37-9	Nitrogen	ND	0.10	
630-08-0	Carbon Monoxide	ND	0.10	
74-82-8	Methane	ND	0.10	
124-38-9	Carbon Dioxide	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

## LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** Lab Control Sample

**Client Project ID:** 2011 Cottonwood RDF Flare

CAS Project ID: P1102313

CAS Sample ID: P110629-LCS

Test Code: EPA Method 3C Modified

Instrument ID: HP5890 II/GC1/TCD

Analyst: Dante Munoz-Castaneda

Sampling Media: 1.0 L Summa Canister

Test Notes:

Date Collected: NA

Date Received: NA

Date Analyzed: 6/29/11

Volume(s) Analyzed: NA ml(s)

CAS #	Compound	Spike Amount ppmV	Result ppmV	% Recovery	CAS Acceptance Limits	Data Qualifier
1333-74-0	Hydrogen	40,300	41,600	103	83-122	
7782-44-7	Oxygen +					
7440-37-1	Argon	50,000	50,000	100	74-132	
7727-37-9	Nitrogen	49,800	48,800	98	76-126	
630-08-0	Carbon Monoxide	49,900	54,000	108	84-113	
74-82-8	Methane	40,300	42,000	104	84-113	
124-38-9	Carbon Dioxide	50,000	51,700	103	87-117	

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Project ID:** 2011 Cottonwood RDF Flare

CAS Project ID: P1102313

**Total Gaseous Nonmethane Organics (TGNMO) as Methane**

Test Code: EPA Method 25C Modified

Instrument ID: HP5890 II/GC1/FID/TCA

Analyst: Dante Munoz-Castaneda

Sampling Media: 1.0 L Summa Canister(s)

Test Notes:

Date(s) Collected: 6/7/11

Date Received: 6/20/11

Date Analyzed: 6/24/11

Client Sample ID	CAS Sample ID	Canister Dilution Factor	Injection Volume ml(s)	Result ppmV	MRL ppmV	Data Qualifier
CW-1	P1102313-001	1.00	0.50	3,100	1.0	
CW-2	P1102313-002	1.00	0.50	3,700	1.0	
CW-3	P1102313-003	1.00	0.50	36	1.0	
Method Blank	P110624-MB	1.00	0.50	ND	1.0	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.



## LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.  
**Client Sample ID:** Lab Control Sample  
**Client Project ID:** 2011 Cottonwood RDF Flare

CAS Project ID: P1102313  
CAS Sample ID: P110624-LCS

**Test Code:** EPA Method 25C Modified  
**Instrument ID:** HP5890 II/GC1/FID/TCA  
**Analyst:** Dante Munoz-Castaneda  
**Sampling Media:** 1.0 L Summa Canister  
**Test Notes:**

Date Collected: NA  
Date Received: NA  
Date Analyzed: 6/24/11  
Volume(s) Analyzed: NA ml(s)

Compound	Spike Amount ppmV	Result ppmV	% Recovery	CAS	Data Qualifier
				Acceptance Limits	
Total Gaseous Nonmethane Organics (TGNMO) as Methane	98.8	97.7	99	71-136	

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## LABORATORY REPORT

November 14, 2011

Andy Limmer, P.G.  
Aquaterra Environmental Solutions, Inc.  
13 Executive Drive, Suite 1  
Fairview Heights, IL 62208

**RE: Cottonwood Hills 2011 Gas / 4733.10**

Dear Andy:

Enclosed are the results of the samples submitted to our laboratory on November 1, 2011. For your reference, these analyses have been assigned our service request number P1104227.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at [www.caslab.com](http://www.caslab.com). Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

Columbia Analytical Services, Inc. is certified by the California Department of Health Services, NELAP Laboratory Certificate No. 02115CA; Arizona Department of Health Services, Certificate No. AZ0694; Florida Department of Health, NELAP Certification E871020; New Jersey Department of Environmental Protection, NELAP Laboratory Certification ID #CA009; New York State Department of Health, NELAP NY Lab ID No: 11221; Oregon Environmental Laboratory Accreditation Program, NELAP ID: CA20007; The American Industrial Hygiene Association, Laboratory #101661; United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), Certificate No. L10-3-R2; Pennsylvania Registration No. 68-03307; TX Commission of Environmental Quality, NELAP ID T104704413-11-2; Minnesota Department of Health, NELAP Certificate No. 219474; Washington State Department of Ecology, ELAP Lab ID: C946. Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact me for information corresponding to a particular certification.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

**Columbia Analytical Services, Inc.**

Sue Anderson  
Project Manager

Client: Aquaterra Environmental Solutions, Inc.  
Project: Cottonwood Hills 2011 Gas / 4733.10

CAS Project No: P1104227

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## CASE NARRATIVE

The samples were received intact under chain of custody on November 1, 2011 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

### BTU and CHONS Analysis

The results for BTU and CHONS were generated according to ASTM D 3588-98. The following analyses were performed and used to calculate the BTU and CHONS results.

#### C2 through C6 Hydrocarbon Analysis

The samples were analyzed according to modified EPA Method TO-3 for C<sub>2</sub> through >C<sub>6</sub> hydrocarbons using a gas chromatograph equipped with a flame ionization detector (FID).

#### Fixed Gases Analysis

The samples were also analyzed for fixed gases (hydrogen, oxygen/argon, nitrogen, carbon monoxide, methane and carbon dioxide) according to ASTM D 1946 using a gas chromatograph equipped with a thermal conductivity detector (TCD).

#### Hydrogen Sulfide Analysis

The were also analyzed for hydrogen sulfide per ASTM D 5504-08 using a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD).

### Total Gaseous Non-Methane Organics as Methane Analysis

The samples were also analyzed for total gaseous non-methane organics as methane according to modified EPA Method 25C. The analyses included a single sample injection (method modification) analyzed by gas chromatography using flame ionization detection/total combustion analysis.

---

*The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. (CAS) is not responsible for utilization of less than the complete report.*

*Use of Columbia Analytical Services, Inc. (CAS) Name. Client shall not use CAS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to CAS any test result, tolerance or specification derived from CAS's data ("Attribution") without CAS's prior written consent, which may be withheld by CAS for any reason in its sole discretion. To request CAS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If CAS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use CAS's name or trademark in any Materials or Attribution shall be deemed denied. CAS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of CAS's name or trademark may cause CAS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.*



# DETAIL SUMMARY REPORT

Client: Aquaterra Environmental Solutions, Inc.  
Project ID: Cottonwood Hills 2011 Gas / 4733.10

Service Request: P1104227

Date Received: 11/1/2011  
Time Received: 09:30

Client Sample ID	Lab Code	Matrix	Date Collected	Time Collected	Container ID	Pi1 (psig)	Pf1 (psig)	TO-3 Modified - C1C6+ Can	3C Modified - Fxd Gases Can	ASTM D5504-01 - H2S Can	25C Modified - TGNMO+ 1X Can
CW-4	P1104227-001	Air	10/26/2011	11:45	1SC00198	-1.94	5.44	X	X	X	X
CW-5	P1104227-002	Air	10/26/2011	12:25	1SC00067	-2.76	5.19	X	X	X	X
CW-6	P1104227-003	Air	10/26/2011	12:50	1SC00803	-2.17	5.20	X	X	X	X



2655 Park Center Drive, Suite A  
Simi Valley, California 93065  
Phone (805) 526-7161  
Fax (805) 526-7270

## Air - Chain of Custody Record & Analytical Service Request

Page 1 of 1

Simi Valley, California 93065 Phone (805) 526-7161 Fax (805) 526-7270						Requested Turnaround Time in Business Days (Surcharges) please circle 1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard						CAS Project No. <b>P1104227</b>		
Company Name & Address (Reporting Information) <b>Aquatera Environmental Solutions</b>						Project Name <b>Cottonwood Hills 2011 GAS</b>						CAS Contact:		Comments e.g. Actual Preservative or specific instructions
												Analysis Method		
Project Manager <b>Andy Linner</b>						Project Number <b>4733.10</b>						<b>Holding Volume ASTM D 5583</b>	<b>Total Nval EPA 25C 5 other gases EPA 3X</b>	
P.O. # / Billing Information														
Email Address for Result Reporting <b>alinner@aquatera-env.com</b>						Sampler (Print & Sign) <b>J. Jordan</b>								
Client Sample ID		Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code #- AC, SC, etc.)	Flow Controller ID (Bar code #- FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume					
CW-4			10/26	1145	1SC00198	AVG 01709	-22	-3.5		X	X			
CW-5			10/26	1225	1SC00067	AVG 01652	-28	-5		X	X			
CW-6			10/26	1250	1SC00803	AVG 01678	-29.5	-5		X	X			
<b>Report Tier Levels - please select</b>												Project Requirements (MRLs, GAPP)		
Tier I - Results (Default if not specified) _____						Tier III (Results + QC & Calibration Summaries) _____							Type: _____	
Tier II (Results + QC Summaries) _____						Tier IV (Data Validation Package) 10% Surcharge _____								
Relinquished by: (Signature)		Date: 10/27/11	Time: 1940	Received by: (Signature)		Date: 11/01/11	Time: 0930							
Relinquished by: (Signature)		Date:	Time:	Received by: (Signature)		Date:	Time:	Cooler / Blank Temperature ____ °C						

4 of 15

WM00574

### Sample Acceptance Check Form

Client: Aquaterra Environmental Solutions, Inc. Work order: P1104227  
Project: Cottonwood Hillls 2011 Gas / 4733.10  
Sample(s) received on: 11/1/11 Date opened: 11/1/11 by: SSTAPLES

**Note:** This form is used for all samples received by CAS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

	Yes	No	N/A
1 Were <b>sample containers</b> properly marked with client sample ID?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 Container(s) <b>supplied by CAS</b> ?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3 Did <b>sample containers</b> arrive in good condition?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4 Were <b>chain-of-custody</b> papers used and filled out?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5 Did <b>sample container labels</b> and/or tags agree with custody papers?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6 Was <b>sample volume</b> received adequate for analysis?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7 Are samples within specified holding times?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8 Was proper <b>temperature</b> (thermal preservation) of cooler at receipt adhered to?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
9 Was a <b>trip blank</b> received?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
10 Were <b>custody seals</b> on outside of cooler/Box?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Location of seal(s)? _____ Sealing Lid?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were signature and date included?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were seals intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were custody seals on outside of sample container?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Location of seal(s)? _____ Sealing Lid?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were signature and date included?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were seals intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
11 Do containers have appropriate <b>preservation</b> , according to method/SOP or Client specified information?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Is there a client indication that the submitted samples are <b>pH</b> preserved?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were <b>VOA vials</b> checked for presence/absence of air bubbles?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Does the client/method/SOP require that the analyst check the sample pH and <u>if necessary</u> alter it?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
12 <b>Tubes:</b> Are the tubes capped and intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Do they contain moisture?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
13 <b>Badges:</b> Are the badges properly capped and intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Are dual bed badges separated and individually capped and intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P1104227-001.01	1.0 L Source Can					
P1104227-002.01	1.0 L Source Can					
P1104227-003.01	1.0 L Source Can					

Explain any discrepancies: (include lab sample ID numbers): \_\_\_\_\_

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.  
**Client Sample ID:** CW-4  
**Client Project ID:** Cottonwood Hills 2011 Gas / 4733.10

CAS Project ID: P1104227  
CAS Sample ID: P1104227-001

**Test Code:** ASTM D3588-98  
**Analyst:** Dante Munoz-Castaneda/Laurn Keeler  
**Sampling Media:** 1.0 L Summa Canister  
**Test Notes:**  
**Container ID:** 1SC00198

**Date Collected:** 10/26/11  
**Date Received:** 11/1/11

**Initial Pressure (psig):** -1.94      **Final Pressure (psig):** 5.44

Canister Dilution Factor: 1.58

Components	Result	Result	Data Qualifier
	Volume %	Weight %	
Hydrogen	0.74	0.05	
Oxygen + Argon	1.69	1.94	
Nitrogen	12.12	12.21	
Carbon Monoxide	< 0.01	< 0.01	
Methane	49.41	28.51	
Carbon Dioxide	35.92	56.88	
Hydrogen Sulfide	< 0.01	< 0.01	
Ethane	< 0.01	< 0.01	
Propane	< 0.01	< 0.01	
Butanes	< 0.01	< 0.01	
Pentanes	< 0.01	0.03	
Hexanes	0.01	0.03	
> Hexanes	0.08	0.31	
<b>TOTALS</b>	<b>99.99</b>	<b>99.99</b>	

Components	Mole %	Weight %
Carbon	22.26	37.17
Hydrogen	52.00	7.29
Oxygen + Argon	19.47	43.32
Nitrogen	6.28	12.22
Sulfur	< 0.10	< 0.10

Specific Gravity (Air = 1)		0.9597
Specific Volume	ft <sup>3</sup> /lb	13.65
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft <sup>3</sup>	508.8
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft <sup>3</sup>	458.1
Gross Heating Value (Water Saturated at 0.25636 psia)	BTU/ft <sup>3</sup>	498.6
Net Heating Value (Water Saturated at 0.25636 psia)	BTU/ft <sup>3</sup>	448.9
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,946.4
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,254.8
Compressibility Factor "Z" (60 F, 14.696 psia)		0.9973



## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.  
**Client Sample ID:** CW-5  
**Client Project ID:** Cottonwood Hills 2011 Gas / 4733.10

CAS Project ID: P1104227  
CAS Sample ID: P1104227-002

**Test Code:** ASTM D3588-98  
**Analyst:** Dante Munoz-Castaneda/Lauryn Keeler  
**Sampling Media:** 1.0 L Summa Canister  
**Test Notes:**  
**Container ID:** 1SC00067

**Date Collected:** 10/26/11  
**Date Received:** 11/1/11

**Initial Pressure (psig):** -2.76      **Final Pressure (psig):** 5.19

Canister Dilution Factor: 1.67

Components	Result	Result	Data Qualifier
	Volume %	Weight %	
Hydrogen	0.72	0.05	
Oxygen + Argon	1.76	2.03	
Nitrogen	12.27	12.34	
Carbon Monoxide	< 0.01	< 0.01	
Methane	49.25	28.37	
Carbon Dioxide	35.83	56.62	
Hydrogen Sulfide	< 0.01	< 0.01	
Ethane	< 0.01	< 0.01	
Propane	< 0.01	< 0.01	
Butanes	< 0.01	< 0.01	
Pentanes	< 0.01	0.03	
Hexanes	0.01	0.03	
> Hexanes	0.12	0.49	
<b>TOTALS</b>	<b>99.99</b>	<b>99.99</b>	

Components	Mole %	Weight %
Carbon	22.25	37.15
Hydrogen	51.96	7.28
Oxygen + Argon	19.44	43.22
Nitrogen	6.34	12.35
Sulfur	< 0.10	< 0.10

Specific Gravity (Air = 1)		0.9614
Specific Volume	ft <sup>3</sup> /lb	13.63
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft <sup>3</sup>	509.9
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft <sup>3</sup>	459.2
Gross Heating Value (Water Saturated at 0.25636 psia)	BTU/ft <sup>3</sup>	499.6
Net Heating Value (Water Saturated at 0.25636 psia)	BTU/ft <sup>3</sup>	450.0
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,949.1
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,258.3
Compressibility Factor "Z" (60 F, 14.696 psia)		0.9973

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.  
**Client Sample ID:** CW-6  
**Client Project ID:** Cottonwood Hills 2011 Gas / 4733.10

CAS Project ID: P1104227  
CAS Sample ID: P1104227-003

**Test Code:** ASTM D3588-98  
**Analyst:** Dante Munoz-Castaneda/Laurn Keeler  
**Sampling Media:** 1.0 L Summa Canister  
**Test Notes:**  
**Container ID:** 1SC00803

Date Collected: 10/26/11  
Date Received: 11/1/11

Initial Pressure (psig): -2.17      Final Pressure (psig): 5.20

Canister Dilution Factor: 1.59

Components	Result	Result	Data Qualifier
	Volume %	Weight %	
Hydrogen	0.73	0.05	
Oxygen + Argon	1.96	2.26	
Nitrogen	12.93	13.00	
Carbon Monoxide	< 0.01	< 0.01	
Methane	48.72	28.04	
Carbon Dioxide	35.48	56.03	
Hydrogen Sulfide	< 0.01	< 0.01	
Ethane	< 0.01	< 0.01	
Propane	< 0.01	< 0.01	
Butanes	< 0.01	< 0.01	
Pentanes	0.01	0.03	
Hexanes	0.01	0.04	
> Hexanes	0.13	0.53	
<b>TOTALS</b>	<b>99.99</b>	<b>99.99</b>	

Components	Mole %	Weight %
Carbon	22.14	36.77
Hydrogen	51.70	7.20
Oxygen + Argon	19.45	43.02
Nitrogen	6.72	13.01
Sulfur	< 0.10	< 0.10

Specific Gravity (Air = 1)		0.9623
Specific Volume	ft <sup>3</sup> /lb	13.62
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft <sup>3</sup>	505.3
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft <sup>3</sup>	455.1
Gross Heating Value (Water Saturated at 0.25636 psia)	BTU/ft <sup>3</sup>	495.1
Net Heating Value (Water Saturated at 0.25636 psia)	BTU/ft <sup>3</sup>	445.9
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,879.9
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,196.3
Compressibility Factor "Z" (60 F, 14.696 psia)		0.9973

# RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** CW-4

**Client Project ID:** Cottonwood Hills 2011 Gas / 4733.10

CAS Project ID: P1104227

CAS Sample ID: P1104227-001

**Test Code:** EPA Method 3C Modified

**Instrument ID:** HP5890 II/GC1/TCD

**Analyst:** Dante Munoz-Castaneda

**Sampling Media:** 1.0 L Summa Canister

**Test Notes:**
**Container ID:** 1SC00198

**Date Collected:** 10/26/11

**Date Received:** 11/1/11

**Date Analyzed:** 11/3/11

**Volume(s) Analyzed:** 0.10 ml(s)

**Initial Pressure (psig):** -1.94

**Final Pressure (psig):** 5.44

**Canister Dilution Factor:** 1.58

CAS #	Compound	Result %, v/v	MRL %, v/v	Data Qualifier
1333-74-0	<b>Hydrogen</b>	<b>0.741</b>	0.16	
7782-44-7	<b>Oxygen +</b>			
7440-37-1	<b>Argon</b>	<b>1.69</b>	0.16	
7727-37-9	<b>Nitrogen</b>	<b>12.1</b>	0.16	
630-08-0	Carbon Monoxide	ND	0.16	
74-82-8	<b>Methane</b>	<b>49.4</b>	0.16	
124-38-9	<b>Carbon Dioxide</b>	<b>35.9</b>	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** CW-5

**Client Project ID:** Cottonwood Hills 2011 Gas / 4733.10

CAS Project ID: P1104227

CAS Sample ID: P1104227-002

Test Code: EPA Method 3C Modified

Instrument ID: HP5890 II/GC1/TCD

Analyst: Dante Munoz-Castaneda

Sampling Media: 1.0 L Summa Canister

Test Notes:

Container ID: 1SC00067

Date Collected: 10/26/11

Date Received: 11/1/11

Date Analyzed: 11/3/11

Volume(s) Analyzed: 0.10 ml(s)

Initial Pressure (psig): -2.76

Final Pressure (psig): 5.19

Canister Dilution Factor: 1.67

CAS #	Compound	Result %, v/v	MRL %, v/v	Data Qualifier
1333-74-0	<b>Hydrogen</b>	<b>0.721</b>	0.17	
7782-44-7	<b>Oxygen +</b>			
7440-37-1	<b>Argon</b>	<b>1.76</b>	0.17	
7727-37-9	<b>Nitrogen</b>	<b>12.3</b>	0.17	
630-08-0	Carbon Monoxide	ND	0.17	
74-82-8	<b>Methane</b>	<b>49.3</b>	0.17	
124-38-9	<b>Carbon Dioxide</b>	<b>35.8</b>	0.17	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.



# RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** CW-6

**Client Project ID:** Cottonwood Hills 2011 Gas / 4733.10

CAS Project ID: P1104227

CAS Sample ID: P1104227-003

**Test Code:** EPA Method 3C Modified

**Instrument ID:** HP5890 II/GC1/TCD

**Analyst:** Dante Munoz-Castaneda

**Sampling Media:** 1.0 L Summa Canister

**Test Notes:**
**Container ID:** 1SC00803

**Date Collected:** 10/26/11

**Date Received:** 11/1/11

**Date Analyzed:** 11/3/11

**Volume(s) Analyzed:** 0.10 ml(s)

**Initial Pressure (psig):** -2.17

**Final Pressure (psig):** 5.20

**Canister Dilution Factor:** 1.59

CAS #	Compound	Result %, v/v	MRL %, v/v	Data Qualifier
1333-74-0	<b>Hydrogen</b>	<b>0.726</b>	0.16	
7782-44-7	<b>Oxygen +</b>			
7440-37-1	<b>Argon</b>	<b>1.96</b>	0.16	
7727-37-9	<b>Nitrogen</b>	<b>12.9</b>	0.16	
630-08-0	Carbon Monoxide	ND	0.16	
74-82-8	<b>Methane</b>	<b>48.7</b>	0.16	
124-38-9	<b>Carbon Dioxide</b>	<b>35.5</b>	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** Method Blank

**Client Project ID:** Cottonwood Hills 2011 Gas / 4733.10

CAS Project ID: P1104227

CAS Sample ID: P111103-MB

**Test Code:** EPA Method 3C Modified

**Instrument ID:** HP5890 II/GC1/TCD

**Analyst:** Dante Munoz-Castaneda

**Sampling Media:** 1.0 L Summa Canister

**Test Notes:**

Date Collected: NA

Date Received: NA

Date Analyzed: 11/03/11

Volume(s) Analyzed: 0.10 ml(s)

CAS #	Compound	Result %, v/v	MRL %, v/v	Data Qualifier
1333-74-0	Hydrogen	ND	0.10	
7782-44-7	Oxygen +			
7440-37-1	Argon	ND	0.10	
7727-37-9	Nitrogen	ND	0.10	
630-08-0	Carbon Monoxide	ND	0.10	
74-82-8	Methane	ND	0.10	
124-38-9	Carbon Dioxide	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

## LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** Lab Control Sample

**Client Project ID:** Cottonwood Hills 2011 Gas / 4733.10

CAS Project ID: P1104227

CAS Sample ID: P111103-LCS

Test Code: EPA Method 3C Modified

Instrument ID: HP5890 II/GC1/TCD

Analyst: Dante Munoz-Castaneda

Sampling Media: 1.0 L Summa Canister

Test Notes:

Date Collected: NA

Date Received: NA

Date Analyzed: 11/03/11

Volume(s) Analyzed: NA ml(s)

CAS #	Compound	Spike Amount ppmV	Result ppmV	% Recovery	CAS Acceptance Limits	Data Qualifier
1333-74-0	Hydrogen	40,300	<b>44,200</b>	<b>110</b>	83-122	
7782-44-7	Oxygen +					
7440-37-1	Argon	50,000	<b>51,600</b>	<b>103</b>	74-132	
7727-37-9	Nitrogen	49,800	<b>50,100</b>	<b>101</b>	76-126	
630-08-0	Carbon Monoxide	49,900	<b>55,000</b>	<b>110</b>	84-113	
74-82-8	Methane	40,300	<b>43,500</b>	<b>108</b>	84-113	
124-38-9	Carbon Dioxide	50,000	<b>53,800</b>	<b>108</b>	87-117	

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Project ID:** Cottonwood Hills 2011 Gas / 4733.10

CAS Project ID: P1104227

**Total Gaseous Nonmethane Organics (TGNMO) as Methane**

Test Code: EPA Method 25C Modified

Instrument ID: HP5890 II/GC1/FID/TCA

Analyst: Dante Munoz-Castaneda

Sampling Media: 1.0 L Summa Canister(s)

Test Notes:

Date(s) Collected: 10/26/11

Date Received: 11/1/11

Date Analyzed: 11/4/11

Client Sample ID	CAS Sample ID	Canister Dilution Factor	Injection Volume ml(s)	Result ppmV	MRL ppmV	Data Qualifier
CW-4	P1104227-001	1.58	0.50	5,500	1.6	
CW-5	P1104227-002	1.67	0.50	5,800	1.7	
CW-6	P1104227-003	1.59	0.50	6,100	1.6	
Method Blank	P111104-MB	1.00	0.50	ND	1.0	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

## LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.  
**Client Sample ID:** Lab Control Sample  
**Client Project ID:** Cottonwood Hills 2011 Gas / 4733.10

CAS Project ID: P1104227  
CAS Sample ID: P111104-LCS

**Test Code:** EPA Method 25C Modified  
**Instrument ID:** HP5890 II/GC1/FID/TCA  
**Analyst:** Dante Munoz-Castaneda  
**Sampling Media:** 1.0 L Summa Canister  
**Test Notes:**

**Date Collected:** NA  
**Date Received:** NA  
**Date Analyzed:** 11/04/11  
**Volume(s) Analyzed:** NA ml(s)

Compound	Spike Amount ppmV	Result ppmV	% Recovery	CAS	Data Qualifier
				Acceptance Limits	
Total Gaseous Nonmethane Organics (TGNMO) as Methane	98.8	98.3	99	71-136	



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## LABORATORY REPORT

June 21, 2011

Randolph Homburg  
Aquaterra Environmental Solutions, Inc.  
13 Executive Dr., Suite 1  
Fairview Heights, IL 62208

### **RE: Cottonwood Hills RDF Flare Sampling / 2011 Cottonwood Hills Gas Testing**

Dear Randolph:

Enclosed are the results of the samples submitted to our laboratory on June 8, 2011. For your reference, these analyses have been assigned our service request number P1102140.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at [www.caslab.com](http://www.caslab.com). Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

Columbia Analytical Services, Inc. is certified by the California Department of Health Services, NELAP Laboratory Certificate No. 02115CA; Arizona Department of Health Services, Certificate No. AZ0694; Florida Department of Health, NELAP Certification E871020; New Jersey Department of Environmental Protection, NELAP Laboratory Certification ID #CA009; New York State Department of Health, NELAP NY Lab ID No: 11221; Oregon Environmental Laboratory Accreditation Program, NELAP ID: CA20007; The American Industrial Hygiene Association, Laboratory #101661; United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), Certificate No. L10-3-R1; Pennsylvania Registration No. 68-03307; TX Commission of Environmental Quality, NELAP ID T104704413-10-1; Minnesota Department of Health, NELAP Certificate No. 219474; Washington State Department of Ecology, ELAP Lab ID: C946. Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact me for information corresponding to a particular certification.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

**Columbia Analytical Services, Inc.**

Sue Anderson  
Project Manager

Client: Aquaterra Environmental Solutions, Inc. CAS Project No: P1102140  
Project: Cottonwood Hills RDF Flare Sampling / 2011 Cottonwood Hills Gas Testing

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## CASE NARRATIVE

The samples were received intact under chain of custody on June 8, 2011 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

### Sulfur Analysis

The samples were analyzed for twenty sulfur compounds per ASTM D 5504-08 using a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD). All compounds with the exception of hydrogen sulfide and carbonyl sulfide are quantitated against the initial calibration curve for methyl mercaptan.

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*The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. (CAS) is not responsible for utilization of less than the complete report.*

*Use of Columbia Analytical Services, Inc. (CAS) Name. Client shall not use CAS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to CAS any test result, tolerance or specification derived from CAS's data ("Attribution") without CAS's prior written consent, which may be withheld by CAS for any reason in its sole discretion. To request CAS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If CAS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use CAS's name or trademark in any Materials or Attribution shall be deemed denied. CAS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of CAS's name or trademark may cause CAS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.*

## DETAIL SUMMARY REPORT

Client: Aquaterra Environmental Solutions, Inc.  
Project ID: Cottonwood Hills RDF Flare Sampling / 2011 Cottonwood Hills Gas Testing

Service Request: P1102140

Date Received: 6/8/2011  
Time Received: 09:40

ASTM D5504-01 - Sulfur Bag

Client Sample ID	Lab Code	Matrix	Date Collected	Time Collected	
CW-1	P1102140-001	Air	6/7/2011	14:22	X
CW-2	P1102140-002	Air	6/7/2011	14:24	X
CW-3	P1102140-003	Air	6/7/2011	14:26	X



Requested Turnaround Time in Business Days (Surcharges) please circle

1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

CAS Project No.

91102140

CAS Contact:

Analysis Method

ASTM D5504  
total sulfur compound

Comments  
e.g. Actual  
Preservative or  
specific instructions

Company Name & Address (Reporting Information)

Aqua Terra Environmental  
13 Executive Dr. Suite 1  
Fairview Heights, IL 62208

Project Name

Cottonwood Hills RDF Flare Sampling

Project Number

2011 Cottonwood Hills GAS Testing

P.O. # / Billing Information

Project Manager

Randolph Homburg

Phone

618 628 2001

Fax

618 628 2002

Email Address for Result Reporting

Rhombury@aquaterra-env.com

Sampler (Print & Sign)

Bob Hill / Collin Carson

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code # - FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume		
<u>CW-1</u>	<u>①</u>	<u>6/7/11</u>	<u>1422</u>	<u>90675-41296</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>.5L</u>		
<u>CW-2</u>	<u>②</u>	<u>6/7/11</u>	<u>1424</u>	<u>90675-41301</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>.5L</u>		
<u>CW-3</u>	<u>③</u>	<u>6/7/11</u>	<u>1426</u>	<u>90675-41299</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>.5L</u>		

Report Tier Levels - please select

Tier I - Results (Default if not specified) \_\_\_\_\_

Tier III (Results + QC & Calibration Summaries) \_\_\_\_\_

EDD required Yes / No

Tier II (Results + QC Summaries) \_\_\_\_\_

Tier IV (Data Validation Package) 10% Surcharge \_\_\_\_\_

Type: \_\_\_\_\_

Project Requirements (MRLs, QAPP)

Relinquished by: (Signature)

[Signature]

Date:

6/7/11

Time:

Received by: (Signature)

[Signature]

Date:

6/8/11

Time:

0940

Relinquished by: (Signature)

Date:

Time:

Received by: (Signature)

Date:

Time:

Cooler / Blank Temperature \_\_\_\_\_ °C

4 of 10

WM00589

### Sample Acceptance Check Form

Client: Aquaterra Environmental Solutions, Inc. Work order: P1102140  
Project: Cottonwood Hills RDF Flare Sampling / 2011 Cottonwood Hills Gas Testing  
Sample(s) received on: 6/8/11 Date opened: 6/8/11 by: MZAMORA

**Note:** This form is used for all samples received by CAS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

	Yes	No	N/A
1 Were <b>sample containers</b> properly marked with client sample ID?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 Container(s) <b>supplied by CAS</b> ?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3 Did <b>sample containers</b> arrive in good condition?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4 Were <b>chain-of-custody</b> papers used and filled out?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5 Did <b>sample container labels</b> and/or tags agree with custody papers?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6 Was <b>sample volume</b> received adequate for analysis?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7 Are samples within specified holding times?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8 Was proper <b>temperature</b> (thermal preservation) of cooler at receipt adhered to?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Cooler Temperature _____ °C Blank Temperature _____ °C			
9 Was a <b>trip blank</b> received?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
10 Were <b>custody seals</b> on outside of cooler/Box?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Location of seal(s)? _____ Sealing Lid?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were signature and date included?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were seals intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were custody seals on outside of sample container?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Location of seal(s)? _____ Sealing Lid?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were signature and date included?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were seals intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
11 Do containers have appropriate <b>preservation</b> , according to method/SOP or Client specified information?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Is there a client indication that the submitted samples are <b>pH</b> preserved?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were <b>VOA vials</b> checked for presence/absence of air bubbles?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Does the client/method/SOP require that the analyst check the sample pH and <u>if necessary</u> alter it?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
12 <b>Tubes:</b> Are the tubes capped and intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Do they contain moisture?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
13 <b>Badges:</b> Are the badges properly capped and intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Are dual bed badges separated and individually capped and intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P1102140-001.01	1 L Zefon Bag					
P1102140-002.01	1 L Zefon Bag					
P1102140-003.01	1 L Zefon Bag					

Explain any discrepancies: (include lab sample ID numbers): \_\_\_\_\_

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc. CAS Project ID: P1102140  
**Client Sample ID:** CW-1 CAS Sample ID: P1102140-001  
**Client Project ID:** Cottonwood Hills RDF Flare Sampling / 2011 Cottonwood Hills Gas Testing

**Test Code:** ASTM D 5504-08 Date Collected: 6/7/11  
**Instrument ID:** Agilent 7890A/GC22/SCD Time Collected: 14:22  
**Analyst:** Wade Henton/Lauryn Keeler Date Received: 6/8/11  
**Sampling Media:** 1 L Zefon Bag Date Analyzed: 6/8/11  
**Test Notes:** Time Analyzed: 11:08  
Volume(s) Analyzed: 0.50 ml(s)

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	39,000	14	28,000	10	
463-58-1	Carbonyl Sulfide	240	25	97	10	
74-93-1	Methyl Mercaptan	11,000	20	5,700	10	
75-08-1	Ethyl Mercaptan	350	25	140	10	
75-18-3	Dimethyl Sulfide	32,000	25	13,000	10	
75-15-0	Carbon Disulfide	170	16	53	5.0	
75-33-2	Isopropyl Mercaptan	1,200	31	380	10	
75-66-1	tert-Butyl Mercaptan	2,400	37	650	10	
107-03-9	n-Propyl Mercaptan	170	31	54	10	
624-89-5	Ethyl Methyl Sulfide	340	31	110	10	
110-02-1	Thiophene	1,500	34	430	10	
513-44-0	Isobutyl Mercaptan	450	37	120	10	W
352-93-2	Diethyl Sulfide	67	37	18	10	
109-79-5	n-Butyl Mercaptan	230	37	63	10	
624-92-0	Dimethyl Disulfide	51	19	13	5.0	
616-44-4	3-Methylthiophene	400	40	98	10	
110-01-0	Tetrahydrothiophene	69	36	19	10	
638-02-8	2,5-Dimethylthiophene	ND	46	ND	10	
872-55-9	2-Ethylthiophene	48	46	10	10	
110-81-6	Diethyl Disulfide	ND	25	ND	5.0	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

W = Result quantified, but the corresponding peak was detected outside of generated retention time window.



## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc. CAS Project ID: P1102140  
**Client Sample ID:** CW-2 CAS Sample ID: P1102140-002  
**Client Project ID:** Cottonwood Hills RDF Flare Sampling / 2011 Cottonwood Hills Gas Testing

**Test Code:** ASTM D 5504-08 Date Collected: 6/7/11  
**Instrument ID:** Agilent 7890A/GC22/SCD Time Collected: 14:24  
**Analyst:** Wade Henton/Lauryn Keeler Date Received: 6/8/11  
**Sampling Media:** 1 L Zefon Bag Date Analyzed: 6/8/11  
**Test Notes:** Time Analyzed: 11:43  
Volume(s) Analyzed: 0.50 ml(s)

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	42,000	14	30,000	10	
463-58-1	Carbonyl Sulfide	250	25	100	10	
74-93-1	Methyl Mercaptan	12,000	20	5,900	10	
75-08-1	Ethyl Mercaptan	370	25	150	10	
75-18-3	Dimethyl Sulfide	34,000	25	13,000	10	
75-15-0	Carbon Disulfide	180	16	58	5.0	
75-33-2	Isopropyl Mercaptan	1,300	31	400	10	
75-66-1	tert-Butyl Mercaptan	2,400	37	660	10	
107-03-9	n-Propyl Mercaptan	180	31	57	10	
624-89-5	Ethyl Methyl Sulfide	360	31	120	10	
110-02-1	Thiophene	1,500	34	450	10	
513-44-0	Isobutyl Mercaptan	440	37	120	10	W
352-93-2	Diethyl Sulfide	74	37	20	10	
109-79-5	n-Butyl Mercaptan	240	37	64	10	
624-92-0	Dimethyl Disulfide	44	19	12	5.0	
616-44-4	3-Methylthiophene	410	40	100	10	
110-01-0	Tetrahydrothiophene	69	36	19	10	
638-02-8	2,5-Dimethylthiophene	ND	46	ND	10	
872-55-9	2-Ethylthiophene	50	46	11	10	
110-81-6	Diethyl Disulfide	ND	25	ND	5.0	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

W = Result quantified, but the corresponding peak was detected outside of generated retention time window.

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc. CAS Project ID: P1102140  
**Client Sample ID:** CW-3 CAS Sample ID: P1102140-003  
**Client Project ID:** Cottonwood Hills RDF Flare Sampling / 2011 Cottonwood Hills Gas Testing

**Test Code:** ASTM D 5504-08 Date Collected: 6/7/11  
**Instrument ID:** Agilent 7890A/GC22/SCD Time Collected: 14:26  
**Analyst:** Wade Henton/Lauryn Keeler Date Received: 6/8/11  
**Sampling Media:** 1 L Zefon Bag Date Analyzed: 6/8/11  
**Test Notes:** Time Analyzed: 12:26  
Volume(s) Analyzed: 0.50 ml(s)

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	36,000	14	26,000	10	
463-58-1	Carbonyl Sulfide	210	25	85	10	
74-93-1	Methyl Mercaptan	10,000	20	5,100	10	
75-08-1	Ethyl Mercaptan	300	25	120	10	
75-18-3	Dimethyl Sulfide	29,000	25	11,000	10	
75-15-0	Carbon Disulfide	140	16	46	5.0	
75-33-2	Isopropyl Mercaptan	1,100	31	340	10	
75-66-1	tert-Butyl Mercaptan	2,000	37	550	10	
107-03-9	n-Propyl Mercaptan	130	31	43	10	
624-89-5	Ethyl Methyl Sulfide	300	31	96	10	
110-02-1	Thiophene	1,300	34	380	10	
513-44-0	Isobutyl Mercaptan	370	37	100	10	W
352-93-2	Diethyl Sulfide	51	37	14	10	
109-79-5	n-Butyl Mercaptan	180	37	48	10	
624-92-0	Dimethyl Disulfide	38	19	10	5.0	
616-44-4	3-Methylthiophene	350	40	87	10	
110-01-0	Tetrahydrothiophene	58	36	16	10	
638-02-8	2,5-Dimethylthiophene	ND	46	ND	10	
872-55-9	2-Ethylthiophene	ND	46	ND	10	
110-81-6	Diethyl Disulfide	ND	25	ND	5.0	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

W = Result quantified, but the corresponding peak was detected outside of generated retention time window.

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc. CAS Project ID: P1102140  
**Client Sample ID:** Method Blank CAS Sample ID: P110608-MB  
**Client Project ID:** Cottonwood Hills RDF Flare Sampling / 2011 Cottonwood Hills Gas Testing

**Test Code:** ASTM D 5504-08 Date Collected: NA  
**Instrument ID:** Agilent 7890A/GC22/SCD Time Collected: NA  
**Analyst:** Wade Henton/Laurn Keeler Date Received: NA  
**Sampling Media:** 1 L Zefon Bag Date Analyzed: 6/08/11  
**Test Notes:** Time Analyzed: 09:22  
Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	ND	7.0	ND	5.0	
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	ND	9.8	ND	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	ND	13	ND	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	ND	9.6	ND	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.



## LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc. CAS Project ID: P1102140  
**Client Sample ID:** Lab Control Sample CAS Sample ID: P110608-LCS  
**Client Project ID:** Cottonwood Hills RDF Flare Sampling / 2011 Cottonwood Hills Gas Testing

Test Code: ASTM D 5504-08 Date Collected: NA  
Instrument ID: Agilent 7890A/GC22/SCD Date Received: NA  
Analyst: Wade Henton/Laurn Keeler Date Analyzed: 6/08/11  
Sampling Media: 1 L Zefon Bag Volume(s) Analyzed: NA ml(s)  
Test Notes:

CAS #	Compound	Spike Amount ppbV	Result ppbV	% Recovery	CAS	Data Qualifier
					Acceptance Limits	
7783-06-4	Hydrogen Sulfide	2,380	1,920	81	71-129	
463-58-1	Carbonyl Sulfide	2,470	2,780	113	66-120	
74-93-1	Methyl Mercaptan	2,360	2,550	108	59-136	



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## LABORATORY REPORT

November 22, 2011

Andy Limmer, P.G.  
Aquaterra Environmental Solutions, Inc.  
13 Executive Drive, Suite 1  
Fairview Heights, IL 62208

**RE: CH RDF Flare Gas Sample / 4733.10**

Dear Andy:

Enclosed are the results of the samples submitted to our laboratory on November 9, 2011. For your reference, these analyses have been assigned our service request number P1104362.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at [www.caslab.com](http://www.caslab.com). Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

Columbia Analytical Services, Inc. is certified by the California Department of Health Services, NELAP Laboratory Certificate No. 02115CA; Arizona Department of Health Services, Certificate No. AZ0694; Florida Department of Health, NELAP Certification E871020; New Jersey Department of Environmental Protection, NELAP Laboratory Certification ID #CA009; New York State Department of Health, NELAP NY Lab ID No: 11221; Oregon Environmental Laboratory Accreditation Program, NELAP ID: CA20007; The American Industrial Hygiene Association, Laboratory #101661; United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), Certificate No. L10-3-R2; Pennsylvania Registration No. 68-03307; TX Commission of Environmental Quality, NELAP ID T104704413-11-2; Minnesota Department of Health, NELAP Certificate No. 219474; Washington State Department of Ecology, ELAP Lab ID: C946. Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact me for information corresponding to a particular certification.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

**Columbia Analytical Services, Inc.**

Sue Anderson  
Project Manager

Client: Aquaterra Environmental Solutions, Inc.  
Project: CH RDF Flare Gas Sample / 4733.10

CAS Project No: P1104362

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## CASE NARRATIVE

The samples were received intact under chain of custody on November 9, 2011 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

### Sulfur Analysis

The samples were analyzed for twenty sulfur compounds per ASTM D 5504-08 using a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD). All compounds with the exception of hydrogen sulfide and carbonyl sulfide are quantitated against the initial calibration curve for methyl mercaptan.

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*The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. (CAS) is not responsible for utilization of less than the complete report.*

*Use of Columbia Analytical Services, Inc. (CAS) Name. Client shall not use CAS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to CAS any test result, tolerance or specification derived from CAS's data ("Attribution") without CAS's prior written consent, which may be withheld by CAS for any reason in its sole discretion. To request CAS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If CAS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use CAS's name or trademark in any Materials or Attribution shall be deemed denied. CAS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of CAS's name or trademark may cause CAS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.*

## DETAIL SUMMARY REPORT

Client: Aquaterra Environmental Solutions, Inc.  
Project ID: CH RDF Flare Gas Sample / 4733.10

Service Request: P1104362

Date Received: 11/9/2011  
Time Received: 09:45

ASTM D5504-01 - Sulfur Bag

Client Sample ID	Lab Code	Matrix	Date Collected	Time Collected
CW-4	P1104362-001	Air	11/8/2011	16:15
CW-5	P1104362-002	Air	11/8/2011	16:20
CW-6	P1104362-003	Air	11/8/2011	16:25

X  
X  
X





### Sample Acceptance Check Form

Client: Aquaterra Environmental Solutions, Inc. Work order: P1104362  
 Project: CH RDF Flare Gas Sample / 4733.10  
 Sample(s) received on: 11/9/11 Date opened: 11/9/11 by: MZAMORA

**Note:** This form is used for all samples received by CAS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

	<b>Yes</b>	<b>No</b>	<b>N/A</b>
1 Were <b>sample containers</b> properly marked with client sample ID?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 Container(s) <b>supplied by CAS</b> ?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3 Did <b>sample containers</b> arrive in good condition?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4 Were <b>chain-of-custody</b> papers used and filled out?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5 Did <b>sample container labels</b> and/or tags agree with custody papers?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6 Was <b>sample volume</b> received adequate for analysis?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7 Are samples within specified holding times?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8 Was proper <b>temperature</b> (thermal preservation) of cooler at receipt adhered to?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
9 Was a <b>trip blank</b> received?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
10 Were <b>custody seals</b> on outside of cooler/Box?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Location of seal(s)? _____ Sealing Lid?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were signature and date included?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were seals intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were custody seals on outside of sample container?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Location of seal(s)? _____ Sealing Lid?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were signature and date included?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were seals intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
11 Do containers have appropriate <b>preservation</b> , according to method/SOP or Client specified information?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Is there a client indication that the submitted samples are <b>pH</b> preserved?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were <b>VOA vials</b> checked for presence/absence of air bubbles?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Does the client/method/SOP require that the analyst check the sample pH and <u>if necessary</u> alter it?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
12 <b>Tubes:</b> Are the tubes capped and intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Do they contain moisture?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
13 <b>Badges:</b> Are the badges properly capped and intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Are dual bed badges separated and individually capped and intact?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P1104362-001.01	1 L Zefon Bag					
P1104362-002.01	1 L Zefon Bag					
P1104362-003.01	1 L Zefon Bag					

Explain any discrepancies: (include lab sample ID numbers): \_\_\_\_\_

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** CW-4

**Client Project ID:** CH RDF Flare Gas Sample / 4733.10

CAS Project ID: P1104362

CAS Sample ID: P1104362-001

Test Code: ASTM D 5504-08

Instrument ID: Agilent 7890A/GC22/SCD

Analyst: Lauryn Keeler

Sampling Media: 1 L Zefon Bag

Test Notes:

Date Collected: 11/8/11

Time Collected: 16:15

Date Received: 11/9/11

Date Analyzed: 11/9/11

Time Analyzed: 12:39

Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	27,000	7.0	20,000	5.0	
463-58-1	Carbonyl Sulfide	300	12	120	5.0	
74-93-1	Methyl Mercaptan	11,000	9.8	5,500	5.0	
75-08-1	Ethyl Mercaptan	390	13	150	5.0	
75-18-3	Dimethyl Sulfide	41,000	13	16,000	5.0	
75-15-0	Carbon Disulfide	280	7.8	90	2.5	
75-33-2	Isopropyl Mercaptan	1,500	16	470	5.0	
75-66-1	tert-Butyl Mercaptan	2,700	18	730	5.0	
107-03-9	n-Propyl Mercaptan	170	16	55	5.0	
624-89-5	Ethyl Methyl Sulfide	460	16	150	5.0	
110-02-1	Thiophene	1,800	17	530	5.0	
513-44-0	Isobutyl Mercaptan	560	18	150	5.0	W
352-93-2	Diethyl Sulfide	72	18	20	5.0	
109-79-5	n-Butyl Mercaptan	260	18	72	5.0	
624-92-0	Dimethyl Disulfide	310	9.6	82	2.5	
616-44-4	3-Methylthiophene	520	20	130	5.0	
110-01-0	Tetrahydrothiophene	93	18	26	5.0	
638-02-8	2,5-Dimethylthiophene	42	23	9.1	5.0	
872-55-9	2-Ethylthiophene	45	23	9.8	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

W = Result quantified, but the corresponding peak was detected outside of generated retention time window.



## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.  
**Client Sample ID:** CW-5  
**Client Project ID:** CH RDF Flare Gas Sample / 4733.10

CAS Project ID: P1104362  
CAS Sample ID: P1104362-002

**Test Code:** ASTM D 5504-08  
**Instrument ID:** Agilent 7890A/GC22/SCD  
**Analyst:** Lauryn Keeler  
**Sampling Media:** 1 L Zefon Bag  
**Test Notes:**

**Date Collected:** 11/8/11  
**Time Collected:** 16:20  
**Date Received:** 11/9/11  
**Date Analyzed:** 11/9/11  
**Time Analyzed:** 12:58  
**Volume(s) Analyzed:** 1.0 ml(s)

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	33,000	7.0	24,000	5.0	
463-58-1	Carbonyl Sulfide	300	12	120	5.0	
74-93-1	Methyl Mercaptan	12,000	9.8	6,200	5.0	
75-08-1	Ethyl Mercaptan	430	13	170	5.0	
75-18-3	Dimethyl Sulfide	41,000	13	16,000	5.0	
75-15-0	Carbon Disulfide	290	7.8	92	2.5	
75-33-2	Isopropyl Mercaptan	1,600	16	520	5.0	
75-66-1	tert-Butyl Mercaptan	2,800	18	760	5.0	
107-03-9	n-Propyl Mercaptan	200	16	63	5.0	
624-89-5	Ethyl Methyl Sulfide	460	16	150	5.0	
110-02-1	Thiophene	2,000	17	580	5.0	
513-44-0	Isobutyl Mercaptan	570	18	160	5.0	W
352-93-2	Diethyl Sulfide	71	18	19	5.0	
109-79-5	n-Butyl Mercaptan	290	18	79	5.0	
624-92-0	Dimethyl Disulfide	210	9.6	54	2.5	
616-44-4	3-Methylthiophene	540	20	130	5.0	
110-01-0	Tetrahydrothiophene	88	18	25	5.0	
638-02-8	2,5-Dimethylthiophene	51	23	11	5.0	
872-55-9	2-Ethylthiophene	60	23	13	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

W = Result quantified, but the corresponding peak was detected outside of generated retention time window.

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** CW-6

**Client Project ID:** CH RDF Flare Gas Sample / 4733.10

CAS Project ID: P1104362

CAS Sample ID: P1104362-003

**Test Code:** ASTM D 5504-08

**Instrument ID:** Agilent 7890A/GC22/SCD

**Analyst:** Lauryn Keeler

**Sampling Media:** 1 L Zefon Bag

**Test Notes:**

Date Collected: 11/8/11

Time Collected: 16:25

Date Received: 11/9/11

Date Analyzed: 11/9/11

Time Analyzed: 13:16

Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	33,000	7.0	23,000	5.0	
463-58-1	Carbonyl Sulfide	280	12	110	5.0	
74-93-1	Methyl Mercaptan	12,000	9.8	6,000	5.0	
75-08-1	Ethyl Mercaptan	420	13	170	5.0	
75-18-3	Dimethyl Sulfide	39,000	13	16,000	5.0	
75-15-0	Carbon Disulfide	270	7.8	88	2.5	
75-33-2	Isopropyl Mercaptan	1,500	16	500	5.0	
75-66-1	tert-Butyl Mercaptan	2,700	18	720	5.0	
107-03-9	n-Propyl Mercaptan	190	16	60	5.0	
624-89-5	Ethyl Methyl Sulfide	450	16	140	5.0	
110-02-1	Thiophene	1,900	17	560	5.0	
513-44-0	Isobutyl Mercaptan	550	18	150	5.0	W
352-93-2	Diethyl Sulfide	64	18	17	5.0	
109-79-5	n-Butyl Mercaptan	290	18	78	5.0	
624-92-0	Dimethyl Disulfide	190	9.6	49	2.5	
616-44-4	3-Methylthiophene	530	20	130	5.0	
110-01-0	Tetrahydrothiophene	88	18	24	5.0	
638-02-8	2,5-Dimethylthiophene	47	23	10	5.0	
872-55-9	2-Ethylthiophene	56	23	12	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

W = Result quantified, but the corresponding peak was detected outside of generated retention time window.

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** Method Blank

**Client Project ID:** CH RDF Flare Gas Sample / 4733.10

CAS Project ID: P1104362

CAS Sample ID: P111109-MB

Test Code: ASTM D 5504-08

Instrument ID: Agilent 7890A/GC22/SCD

Analyst: Lauryn Keeler

Sampling Media: 1 L Zefon Bag

Test Notes:

Date Collected: NA

Time Collected: NA

Date Received: NA

Date Analyzed: 11/09/11

Time Analyzed: 09:18

Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result $\mu\text{g}/\text{m}^3$	MRL $\mu\text{g}/\text{m}^3$	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	ND	7.0	ND	5.0	
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	ND	9.8	ND	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	ND	13	ND	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	ND	9.6	ND	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

## LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

**Client:** Aquaterra Environmental Solutions, Inc.

**Client Sample ID:** Lab Control Sample

**Client Project ID:** CH RDF Flare Gas Sample / 4733.10

CAS Project ID: P1104362

CAS Sample ID: P111109-LCS

Test Code: ASTM D 5504-08

Instrument ID: Agilent 7890A/GC22/SCD

Analyst: Lauryn Keeler

Sampling Media: 1 L Zefon Bag

Test Notes:

Date Collected: NA

Date Received: NA

Date Analyzed: 11/09/11

Volume(s) Analyzed: NA ml(s)

CAS #	Compound	Spike Amount ppbV	Result ppbV	% Recovery	CAS	Data Qualifier
					Acceptance Limits	
7783-06-4	Hydrogen Sulfide	2,380	2,040	86	51-141	
463-58-1	Carbonyl Sulfide	2,470	1,940	79	63-147	
74-93-1	Methyl Mercaptan	2,360	2,290	97	54-156	



APPENDIX C  
CALCULAITONS

# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## NET HEATING VALUE CALCULATIONS

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

### Input

Sample No.	CW-1		
Date Collected	6/7/2011		
Percent Methane:	51.4	Percent	
Net heat of combustion of methane*	802	KJ/g mole	

Net Heating Value calculated using the following equation:

$$HT = K \sum C_i H_i$$

where:

H (T): Net Heating Value in (MJ/scm) at 25 deg. C, 760 mm Hg

K:  $1.740 \times 10^{-7}$  (1/ppm)(g mole/scm)(MJ/kcal)

where (g mole/scm) is at 20 deg. C

$C_i$ : concentration of component sample component  $i$  in ppm

$H_i$ : net heat of combustion for sample component  $i$

in (kcal/g mole) at 25 deg. C, 760 mm Hg

### Convert Heat of Combustion from Btu/scf to kcal/g mole

A) KJ/mol to J/mol

$$(802 \text{ kJ/g mole}) \times (1000 \text{ J/1 kJ}) = 802,000 \text{ J/g mole}$$

B) J/mole to cal/mole

$$(802,000 \text{ J/g mole}) \times (1 \text{ cal/4.184 J}) = 191,682.6 \text{ cal/g mole}$$

C) cal/mole to Kcal/mole

$$(191,682 \text{ cal/g mole}) \times (1 \text{ Kcal/1000 cal}) = 191.7 \text{ kcal/g mole}$$

### Now calculate Net Heating Value

$$HT = K \sum C_i H_i$$

$$H(T) = 1.740 \times 10^{-7} (1/\text{ppm})(\text{g mole/scm})(\text{MJ/kcal}) \times 514000 \text{ ppm} \times 191.7 \text{ kcal/g-mole}$$

$$H(T) = 17.14 \text{ MJ/scm}$$

\* Value from *Chemistry: The Central Science 2nd Edition*, by Theodore L. Brown and H. Eugene LeMay, Jr.



# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## NET HEATING VALUE CALCULATIONS

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

### Input

Sample No.	CW-2		
Date Collected	6/7/2011		
Percent Methane:		57.13	Percent
Net heat of combustion of methane*		802	KJ/g mole

Net Heating Value calculated using the following equation:

$$HT = K \sum C_i H_i$$

where:

H (T): Net Heating Value in (MJ/scm) at 25 deg. C, 760 mm Hg

K:  $1.740 \times 10^{-7}$  (1/ppm)(g mole/scm)(MJ/kcal)

where (g mole/scm) is at 20 deg. C

C<sub>i</sub>: concentration of component sample component *i* in ppm

H<sub>i</sub>: net heat of combustion for sample component *i*  
in (kcal/g mole) at 25 deg. C, 760 mm Hg

Convert Heat of Combustion from Btu/scf to kcal/g mole

A) KJ/mol to J/mol	(802 kJ/g mole)*(1000 J/1 kJ) =	802,000 J/g mole
B) J/mole to cal/mole	(802,000 J/g mole)*(1 cal/4.184 J)=	191,682.6 cal/g mole
C) cal/mole to Kcal/mole	(191,682 cal/g mole)*(1 Kcal/1000 cal)=	191.7 kcal/g mole

Now calculate Net Heating Value

$$HT = K \sum C_i H_i$$

$$H(T) = 1.740 \times 10^{-7} (1/\text{ppm})(\text{g mole/scm})(\text{MJ/kcal}) \times 571300 \text{ ppm} \times 191.7 \text{ kcal/g-mole}$$

$$H(T) = 19.06 \text{ MJ/scm}$$

\* Value from *Chemistry: The Central Science 2nd Edition*, by Theodore L. Brown and H. Eugene LeMay, Jr.

# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## NET HEATING VALUE CALCULATIONS

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

Input \_\_\_\_\_

Sample No.	CW-4		
Date Collected:	10/26/2011		
Percent Methane:		49.41	Percent
Net heat of combustion of methane*		802	KJ/g mole

Net Heating Value calculated using the following equation:

$$HT = K \sum C_i H_i$$

where:

H (T): Net Heating Value in (MJ/scm) at 25 deg. C, 760 mm Hg

K:  $1.740 \times 10^{-7}$  (1/ppm)(g mole/scm)(MJ/kcal)

where (g mole/scm) is at 20 deg. C

C<sub>i</sub>: concentration of component sample component *i* in ppm

H<sub>i</sub>: net heat of combustion for sample component *i*  
in (kcal/g mole) at 25 deg. C, 760 mm Hg

Convert Heat of Combustion from Btu/scf to kcal/g mole

A) KJ/mol to J/mol

$$(802 \text{ kJ/g mole}) \times (1000 \text{ J/1 kJ}) = 802,000 \text{ J/g mole}$$

B) J/mole to cal/mole

$$(802,000 \text{ J/g mole}) \times (1 \text{ cal/4.184 J}) = 191,682.6 \text{ cal/g mole}$$

C) cal/mole to Kcal/mole

$$(191,682 \text{ cal/g mole}) \times (1 \text{ Kcal/1000 cal}) = 191.7 \text{ kcal/g mole}$$

Now calculate Net Heating Value

$$HT = K \sum C_i H_i$$

$$H(T) = 1.740 \times 10^{-7} (1/\text{ppm})(\text{g mole/scm})(\text{MJ/kcal}) \times 494100 \text{ ppm} \times 191.7 \text{ kcal/g-mole}$$

$$H(T) = 16.48 \text{ MJ/scm}$$

\* Value from *Chemistry: The Central Science 2nd Edition*, by Theodore L. Brown and H. Eugene LeMay, Jr.

# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## NET HEATING VALUE CALCULATIONS

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

Input

---

Sample No.	CW-5		
Date Collected:	10/26/2011		
Percent Methane:		49.25	Percent
Net heat of combustion of methane*		802	KJ/g mole

Net Heating Value calculated using the following equation:

$$HT = K \sum CiHi$$

where:

H (T): Net Heating Value in (MJ/scm) at 25 deg. C, 760 mm Hg

K:  $1.740 \times 10^{-7}$  (1/ppm)(g mole/scm)(MJ/kcal)

where (g mole/scm) is at 20 deg. C

$C_i$ : concentration of component sample component  $i$  in ppm

$H_i$ : net heat of combustion for sample component  $i$   
in (kcal/g mole) at 25 deg. C, 760 mm Hg

Convert Heat of Combustion from Btu/scf to kcal/g mole

A) KJ/mol to J/mol

$$(802 \text{ kJ/g mole}) \times (1000 \text{ J/1 kJ}) = 802,000 \text{ J/g mole}$$

B) J/mole to cal/mole

$$(802,000 \text{ J/g mole}) \times (1 \text{ cal/4.184 J}) = 191,682.6 \text{ cal/g mole}$$

C) cal/mole to Kcal/mole

$$(191,682 \text{ cal/g mole}) \times (1 \text{ Kcal/1000 cal}) = 191.7 \text{ kcal/g mole}$$

Now calculate Net Heating Value

$$HT = K \sum CiHi$$

$$H(T) = 1.740 \times 10^{-7} (1/\text{ppm})(\text{g mole/scm})(\text{MJ/kcal}) \times 492500 \text{ ppm} \times 191.7 \text{ kcal/g-mole}$$

$$H(T) = 16.43 \text{ MJ/scm}$$

\* Value from *Chemistry: The Central Science 2nd Edition*, by Theodore L. Brown and H. Eugene LeMay, Jr.

# AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

## NET HEATING VALUE CALCULATIONS

Waste Management, Inc.  
Cottonwood Hills Recycling and Disposal Facility  
Marissa, Illinois

### Input

Sample No.	CW-6		
Date Collected:	10/26/2011		
Percent Methane:	48.72	Percent	
Net heat of combustion of methane*	802	KJ/g mole	

Net Heating Value calculated using the following equation:

$$HT = K \sum C_i H_i$$

where:

H (T): Net Heating Value in (MJ/scm) at 25 deg. C, 760 mm Hg

K:  $1.740 \times 10^{-7}$  (1/ppm)(g mole/scm)(MJ/kcal)

where (g mole/scm) is at 20 deg. C

C<sub>i</sub>: concentration of component sample component *i* in ppm

H<sub>i</sub>: net heat of combustion for sample component *i*  
in (kcal/g mole) at 25 deg. C, 760 mm Hg

Convert Heat of Combustion from Btu/scf to kcal/g mole

A) KJ/mol to J/mol

$$(802 \text{ kJ/g mole}) \times (1000 \text{ J/1 kJ}) = 802,000 \text{ J/g mole}$$

B) J/mole to cal/mole

$$(802,000 \text{ J/g mole}) \times (1 \text{ cal/4.184 J}) = 191,682.6 \text{ cal/g mole}$$

C) cal/mole to Kcal/mole

$$(191,682 \text{ cal/g mole}) \times (1 \text{ Kcal/1000 cal}) = 191.7 \text{ kcal/g mole}$$

Now calculate Net Heating Value

$$HT = K \sum C_i H_i$$

$$H(T) = 1.740 \times 10^{-7} (1/\text{ppm})(\text{g mole/scm})(\text{MJ/kcal}) \times 487200 \text{ ppm} \times 191.7 \text{ kcal/g-mole}$$

$$H(T) = 16.25 \text{ MJ/scm}$$

\* Value from *Chemistry: The Central Science 2nd Edition*, by Theodore L. Brown and H. Eugene LeMay, Jr.